Dark Energy and the Hubble Constant

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ABSTRACT

Dark energy is inferred from a Hubble expansion which is slower at epochs which are earlier than ours. But evidence reviewed here shows H_0 for nearby galaxies is actually less than currently adopted and would instead require *deceleration* to reach the current value.

Distances of Cepheid variables in galaxies in the Local Supercluster have been measured by the Hubble Space Telescope and it is argued here that they require a low value of H_0 along with redshifts which are at least partly intrinsic. The intrinsic component is hypothesized to be a result of the particle masses increasing with time.

The same considerations apply to Dark Matter. But with particle masses growing with time, the condensation from plasmoid to proto galaxy not only does away with the need for unseen "dark matter" but also explains the intrinsic (non-velocity) redshifts of younger matter.

Subject headings: **Cepheids — galaxies:distances and redshifts**

Introduction

Recent analysis of supernovae data yields $H_0 = 65$ km/sec/Mpc up to a redshift of z = .35 (Shafieloo 2007). If we take the currently accepted value out to about 25 Mpc in our own neighborhood then $H_0 = 72$ km/sec/Mpc. (Freedman et al. 2001). This is interpreted as an acceleration in an expanding universe from 65 to 72 in the time from z = .35 to the present.

But if the Hubble constant appropriate to our nearby galaxies is $H_0 = 55$ (not 72) we are left with a deceleration of -10 km/sec/Mpc instead of an acceleration of + 7 km/sec/Mpc. As an average this would indicate a contraction (Due to negative Dark Energy?) of -1.5 ± 8.5 km/sec/Mpc - an imprecision suggestive of no meaningful evidence for dark energy. (See Table 1).

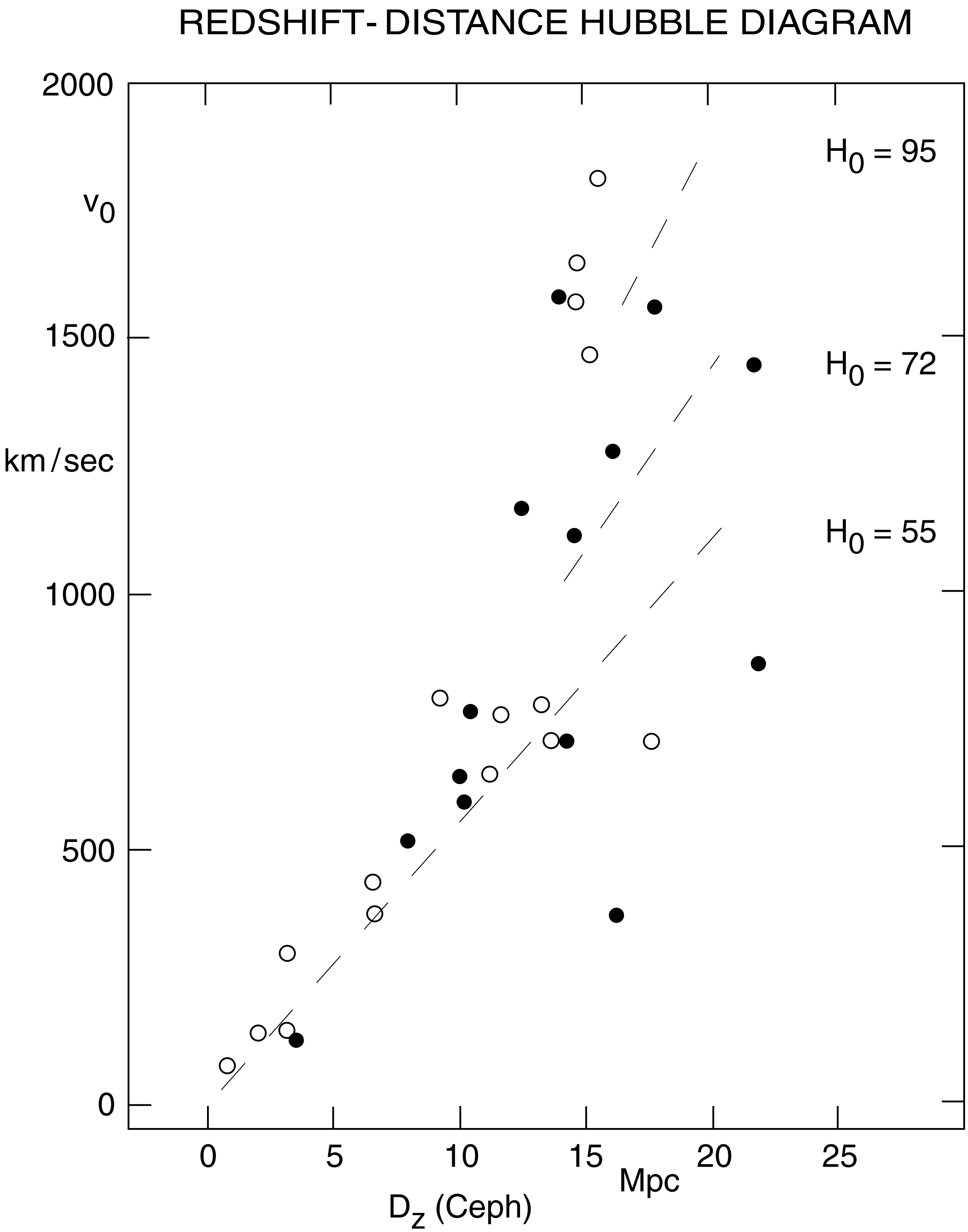

Fig. 1.— The Cepheid distance, D_z(Ceph), is plotted against Local Group centered redshift (v_0) for available galaxies. For low redshift galaxies a very accurate fit to $H_0 = 55$ is evident. Greater than 800 km/sec, however, excess redshifts appear which are too large and too positive to be peculiar velocities. Filled circles are Sb, open circles Sc.

Table 1: Dark Energy

Region	H_0	$DarkEnergy$
z = .35	65	
Local SuperCluster	72	+7 km/sec/Mpc
Local SuperCluster	55	-10 km/sec/Mpc

1. What is H_0 Locally?

In view of the contradictory results obtained from the analysis of the HST data on local H_0, it is important to see if any dark energy values can be reconciled.

The Cepheid distances are considered to be the most accurate distances available. The Hubble Space Telescope was used to measure light curves in order to obtain mean magnitudes and periods. The most illuminating display of the data is in the redshift - distance diagram shown here in Fig. 1. Clearly the nearest spirals with Cepheids define accurately the H_0 = 55 line. Greater than about 800 km/sec, however, the deviations are well above the H_0 = 55 line.

The galaxies which fall above the line at higher redshifts are predominantly high luminosity class, high z spirals. The evidence for intrinsic redshifts then lies in the fact that, for luminosity class I galaxies, their redshifts are much too high to give reasonable Hubble constants. (See Table 1 of Arp 2002.)

Another way of judging the existence of intrinsic (non velocity) redshifts is to examine the Virgo Cluster. It has been known for a long time that the late type spirals appear to be members of this rich cluster. But it was argued by G. de Vaucouleurs among others that these spirals, because of their higher redshift, were actually a separate cluster at a greater distance behind, and only accidently aligned with, the Virgo Cluster. It did not swing opinion when it was shown that Sc galaxies in mixed groups and clusters exhibited sytematically higher redshifts (Arp 1990, 1998). With the recent Cepheid distances, however it is now possible to make a definitive test for the Virgo spirals. They turn out to be 15 Mpc distant, almost exactly at the center of the Virgo Cluster (Fig. 1). The excess redshift of spiral galaxies which contain type I Cepheids then requires a smaller H_0 which gives no evidence that would require Dark Energy.

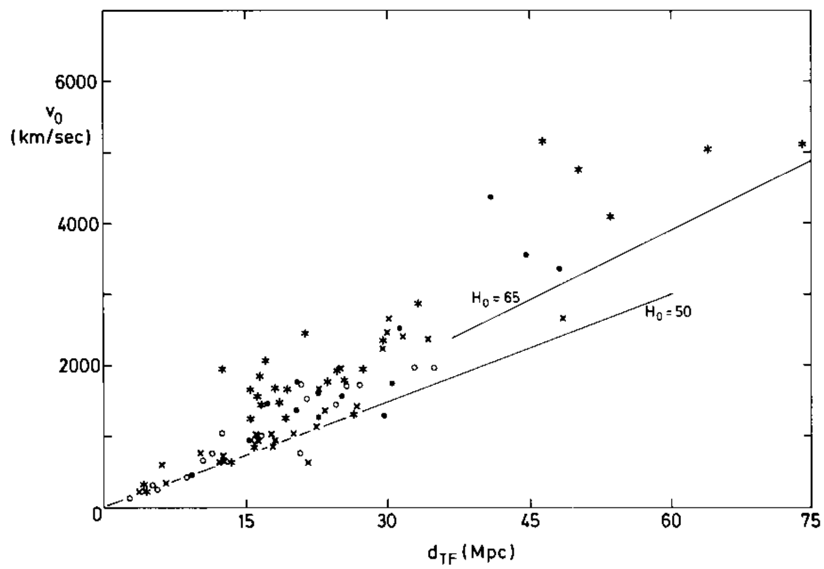

Fig. 2.— The Tully-Fisher distance ($d_T F$) is plotted against Local Group centered redshift (v_0) for Sc's. Asterisks denote Local Group direction. For low redshift galaxies a very accurate fit is evident. Data and Figure from Arp (1990).

1.1. Independent Checks on Redshift Distances

Two of the strongest independent confirmations of excess redshifts are:

1) Tully-Fisher distances from rotational velocity data. Fig. 2 shows that Tully/Fisher within 15 Mpc agrees well with Cepheid distances and low H_0 but that at greater distances the redshifts become excessive. Unless space is expanding faster in earlier times (opposite to that of Dark Energy) the redshifts must be intrinsic.

2) If we take the redshift of the brightest galaxy in Virgo - presumably the most massive in the cluster - we obtain:

$$H_0 = 822/15.3 = 53.7 km/sec/Mpc$$

It is also interesting to note that Sandage and Tamman regularly obtained H_0 near 55. They stress, however the use of volume limited samples. (Sandage, Tamman and Saha 1998). Ironically their volume was thus defined by using redshift distances which thereby excluded the excess (intrinsic) redshift galaxies. Hence they obtained the low but more correct H_0 for galaxies near the age of our Milky Way. Note, however, their $H_0 = 62$ in a later group paper (Sandage et al. 2006) where they extend the redshift volume to about 20,000 km/sec.

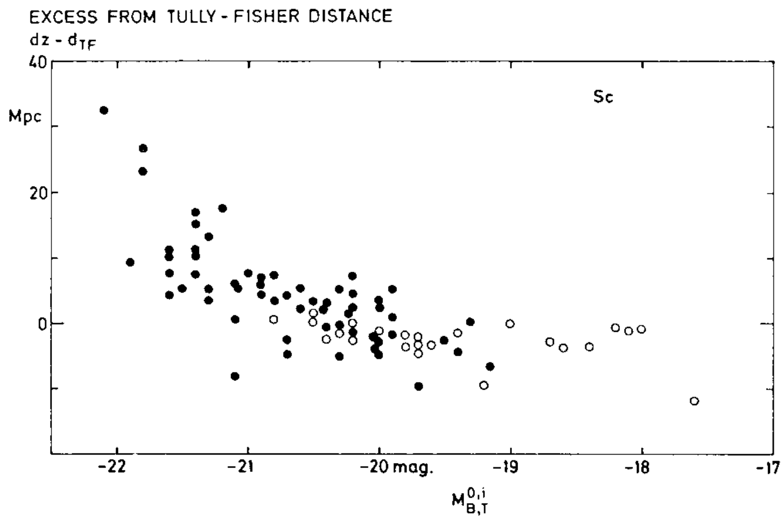

Fig. 3.— The excess of redshift distance over Tully-Fisher distance $(d_z - d_{TF})$ is plotted as a function of blue luminosity as derived in Arp (1990). Open circles are Sc's with $v_0 \leq 1000$ km/sec and demonstrate that redshift and Tully-Fisher distances agree well for low redshift galaxies over a wide range in luminosity.

Naturally they now include some of these intrinsic redshift galaxies which raise the Hubble constant above the earlier, more correct, derived values. We see from Fig.3 that the redshift distances for such galaxies can give distances discrepant by up to 30 Mpc.

Finally Morley Bell (2007) notes ". . . the local Hubble constant is found to be $H_0 =$ 58 km/sec/Mpc when the intrinsic components are removed."

2. The variable Mass theory

At this point it would help to place the observational phenomenon of intrinsic redshift into a theory which could connect it to the world of accepted physics. We look first at the Einstein field equations, the fundamental energy/momentum conservation statement that furnishes the departure point for rigorous cosmological theories. The key to the general solution of the equations based on the Hoyle/Narlikar Machian gravitation theory is elementary particle masses varying as m = m(t) Narlikar (1977). For a constant mass approximation the theory reduces to the standard Einstein theory. However, the input from Mach's principle suggests that the inertia of a newly created particle starts off as zero and grows with its age as it begins to get contributions from more and more remote matter in the universe. The typical wavelengths emitted by a particle (such as the electron in a hydrogen atom) would

reduce as its mass grows. Thus newly created matter would exhibit high intrinsic redshift. In such a framework, the intrinsic redshift of all galaxies created at the same time as our own will always give a perfect Hubble relation because the look back time to a distant galaxy will always reveal it at a younger age when its intrinsic redshift was exactly that predicted by the Hubble law, cz = d x Ho. Younger galaxies would have intrinsic redshifts.

2.1. The Indeterminancy of Dark Energy

We observe redshifted supernovae at earlier stages in their evolution due to look-back time. If they are young enough to have appreciable intrinsic redshift then we would calculate a higher H_0 at the epoch of the supernova and we would have to slow down the supposed cosmic expansion to match our current H_0. This would be opposite to the dark energy being widely discussed at present.

Of course younger galaxies that are evolving the mass of their elementary particles would shine with a somewhat weaker light than nearby standard supernovae so we would tend to derive a greater than true distance for them. The resulting Hubble constant could be smaller than for our local neighborhood and we might conclude that the universe is now expanding faster than in the past.

The two effects would tend to vie with each other for dominance at any given time. And since both are very difficult to calculate the true expansion velocity, if indeed there is any expansion, would be indeterminant regardless of how accurately our local H_0 were to be agreed on. Simon White presciently remarked anent Dark Energy: "Unfortunately, the progenitors of higher redshift supernovae formed and exploded in younger galaxies than their lower redshift counterparts, and this could plausibly cause small redshift-dependent shifts in the properties of the supernovae or of their immediate environments. Undetected shifts of this kind could confuse the search for the Dark Energy signal and limit the precision with which it can be measured" (White, S. 2007 arXiv: 0704.229).

2.2. Suggestions of Local Expansion

Recently Chernin et al(2007) have interpreted long standing observations of groups of galaxies in terms of cells of dark matter expansion. The problem here is that analyses of these groups have shown repeatedly that the smaller companions around the dominant group galaxy are of systematically higher redshift.(E.g. 22 out of 22 major companions to M 31and M 81 have higher redshifts). (Arp 1994;1998a;1998b) If the groups were expanding

one would expect as many approaching as receding galaxies as we obeserve them. In fact the observations in many groups and clusters demonstrate the reality of the intrinsic redshift, the same redshift that requires the low H_0 in our Local Group galaxies and which, as the preceding discussion argues, points to dark energy as not having been detected.

2.3. Dark Matter and Formation of Galaxies

The evidence for intrinsic redshifts discussed in the determination of local H_0 is pertinent to the subject of dark matter in galaxy formation. With particle masses growing with time as t^2 (Narlikar and Arp 1993), the condensation from plasmoid to proto galaxy in the early stages is not only accomplished without the need for unseen "dark matter" but also explains the intrinsic redshifts of younger matter. For example the long debated association of high redshift quasars with active low redshift galaxies then leads to a continuous evolution from quasars through active galaxies to older galaxies on the Hubble relation in a continuously creating Universe. (See arXiv.0711.2607 for discussion of Quasars and the Hubble relation.)

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